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ABSTRACT

The Learning in Science Project (Primary)--LISP(P)--developed a handbook for a unit on "floating and sinking". The handbook contains information about ideas children and scientists have about the topic and several investigations and projects designed to help teachers move children gradually from intuitive explanations toward those which will ultimately be more useful to them. This paper is part of a formative evaluation of the handbook. Analyses included focus on: (1) unit objectives (which are not stated formally in the unit); (2) time allocation (not specified in the unit); (3) vocabulary; (4) definitions provided; (5) scientific background provided; (6) emphasis placed on teachers knowing about the ideas their students bring to their lessons; (7) sequencing of activities; (8) model of science fostered; (9) attitudes toward the learning of science fostered; and (10) instructional strategies. Questions provoked by these analyses are recorded for each area addressed. So that the authors of the handbook could respond to some of the questions, a set of questions was prepared and presented to them. The questions and the responses are included in an appendix. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

AN ANALYSIS OF THE LISP (P) UNIT - FLOATING AND SINKING

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Working Paper No. 118

AN ANALYSIS OF THE LISP(P)

UNIT - FLOATING AND SINKING

David Symington

November 1983

LISP Working Paper No. 118

PREFACE

In November 1983 Dr David Symington of Victoria College, Melbourne, visited the Science Education Research Unit for three weeks. At that time the Learning in Science Project (Primary) team had just produced a Unit of work for teachers; "Floating and Sinking: some teaching suggestions". As our intention was to evaluate this Unit, Dr Symington's visit provided an excellent opportunity to obtain an independent "armchair" evaluation of the draft Unit as one input to the formative evaluation process. We are grateful to David Symington for the analysis described in this paper as he not only raises a number of important points but suggests factors which will have to be considered in the classroom evaluation of the Unit.

INTRODUCTION

Since it began, the Learning in Science Project (Primary) [LISP(P)] has been based on the assumption that:

- the aim of primary school science is to help the pupils make better sense of their natural, physical and technological world; and that

- an important step toward the achievement of this aim is to ensure that the teacher feels in control of the classroom environment.

(see Symington, Osborne, Freyberg and White, 1982)

Much of the activity of the LISP(P) team to date has been centred on the collection of data about the ideas pupils currently hold (see e.g. Biddulph, 1982, 1983a, 1983b). This was seen as an important starting point because the team accepts the validity of Ausubel's claim that 'the most important single factor influencing learning is what the learner already knows' (Ausubel, 1968). It was believed that teachers' confidence about their ability to handle science effectively would be enhanced if they had an understanding of the sorts of ideas that their pupils were likely to bring into the classroom.

Beside this research into children's ideas the LISP(P) team has been encouraging teachers to explore teaching strategies which build upon the current thinking of pupils as expressed in the explanations they generate and the questions they ask (see Biddulph & Roger, 1983; Biddulph & McMinn, 1983).

Out of this aspect of the LISP(P) activity has come the conviction that there are some teachers who feel perfectly confident to build a classroom program on a topic for their own pupils based upon the questions asked and the ideas expressed by those pupils with respect to that topic. It is believed, however, that there are other teachers whose feelings of control over the learning within their classroom would be enhanced if they were provided with a framework which suggests strategies for building a program based upon children's thinking.

Accordingly, on the topic of sinking and floating, in addition to a working paper (Biddulph, 1983b) which sets out students' views of floating and sinking, a teachers' handbook (Biddulph, Freyberg & Osborne, 1983) has been produced. The present paper is seen as part of a formative evaluation of that handbook.

Questions provoked by the analysis are recorded as they arise. It seemed appropriate to ask the authors of the LISP(P) handbook to respond to some of these. Accordingly a set of questions was prepared and presented to the LISP(P) authors. The questions and the responses to them are included in the paper as Appendix A.

THE ANALYSIS

1. Objectives of the Unit

1.1 Identification of objectives

Whereas the majority of teacher handbooks contain a formal statement of objectives the objectives of the LISP unit are not labelled as such. This fact raises questions about the importance to teachers of statements of objectives.

Questions (Set A)

1. Why didn't the LISP authors produce a labelled set of objectives for the unit?

2. Do teachers read statements of objectives?

3. Is teaching behaviour affected by the presence or absence of formal statements of objectives?

4. Are teachers concerned if objectives are not specifically stated?

The author of this paper selected a set of statements from the handbook which appear to express the objectives of the LISP unit. These statements are set out in Table 1.

TABLE 1: INFERRED OBJECTIVES FOR THE LISP HANDBOOK - FLOATING AND SINKING

1. Overall content objective

The most useful concept for the children to develop at the primary school level is that an object will float if it is light for its size. (Pg. 7)

2. Objectives for the investigations

2.1 Content

- to gain some understanding of flotation
- to acquire some scientific facts (e.g. which materials float and which do not?) (Pg. 8)

2.2 Skills

- to develop various skills of processing information (e.g. predicting, observing, reasoning) (Pg. 8)

3. Objectives for the experimental projects

The children should recognise

- that ideas in science must be testable. (Pg. 12)

4. Objectives for the non-experimental projects

The children can

- gain some knowledge of social value
- recognise that science can help them make better sense of their world (Pg. 16)

1.2 The approach adopted

The first statement (that labelled in Table 1 as the overall content objective) reads like a traditional teaching objective, that is, it suggests a concept that the pupils may be expected to have acquired from the unit. [The first investigation (pages 8 and 9) provides an activity designed to assist students to acquire this concept.] However the general approach to the unit is far from traditional. Most of the activities suggested in the booklet are designed to lead students to refute or modify their existing ideas. This is alluded to when the text suggests that:

> "Some of the ideas (e.g. 1, 2, 8 and 9) we would want to challenge, some (e.g. 4, 5, 7 and 7) we would want to modify, whilst others we would want to explore and enrich (e.g. 3)".
>
> (Pg. 7)

Since the general approach of the unit is radically different from that traditionally followed it may be even more important to specify objectives in unambiguous terms.

Questions (Set B)

1. Would the inclusion of a set of objectives which indicate that the unit is designed to challenge and modify some of the existing ideas of the children increase the likelihood of the unit being used as the authors intended? [This is an elaboration of Question 3 in Set A.]

1.3 Skill development

Although the unit, in all but the last section, is based upon students using scientific skills there is no emphasis in the handbook on the development of skills. In this respect this unit is markedly different from the primary units produced by the Department of Education. They provide detailed statements about objectives in the skills area.

Questions (Set C)

1. Why did the LISP authors not include detailed statements about skill development?

2. Do teachers believe that there should be additional material in the unit which specifies skill development?

3. Does the absence of detailed statements about skill objectives influence the way teachers evaluate pupil development as a result of the unit?

1.4 Knowledge of social value

One of the objectives identified in Table 1 is that the pupils should, 'gain some knowledge of social value'. It is suggested in the handbook that this objective should be reached by involving pupils in one or more non-experimental projects from a list provided. This raises the question of whether there is a degree of consensus on what constitutes knowledge of social worth.

Questions (Set D)

1. Do teachers accept that the acquisition of knowledge of social value is an objective appropriate to primary science?

2. Do the teachers believe that the knowledge likely to be gained by involvement in the suggested projects is of social value?

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2. Time Allocation

The LISP authors have not specified the time which may be required for the unit.

Questions (Set E)

1. Why did the LISP authors not specify a time allocation for the unit?

2. Do teachers appreciate an indication of the time which may be required for a unit?

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3. Vocabulary

Although there is wide acceptance that primary teachers generally have a limited background in science and hence may be discouraged and confused by the use of technical vocabulary, the LISP handbook does use, without definition, some words which may not be appropriately understood by teachers. Table 2 sets out words which may be such a cause of confusion.

TABLE 2: VOCABULARY USED, WITHOUT DEFINITION, IN THE TEACHER HANDBOOK

- relative density	- density
- surface tension	- force

Questions (Set F)

1. Do the words presented in Table 2 cause any problems for teachers?

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4. Definitions Provided

Although some technical vocabulary is used undefined, the LISP handbook deals thoroughly with the word 'floating', not only identifying the meaning to be used within the booklet but also pointing to the fact that others may interpret the word differently (see Table 3).

Further, the LISP material provides an operational definition of 'floatability' - 'the greater the force to push the material under the waterline the greater the floatability' (see Table 3).

Questions (Set G)

1. Does the provision of these definitions of 'floating' and 'floatability' in the LISP handbook promote more effective handling of the topic by teachers?

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5. The Scientific Background Provided

In the LISP material there is a brief, labelled statement to represent the scientists' view of the phenomenon to be studied in each of the four investigations and in the first of the experimental projects.

TABLE 3: DEFINITIONS PROVIDED IN THE TEACHER HANDBOOK

1. Floating

Floating is a complex phenomenon. There are at least 3 types of floating.

1. Floating on a liquid
   - partly submerged, e.g. iceberg

2. Floating within a liquid
   - wholly submerged, e.g. fish

3. Floating on top of a liquid
   - wholly supported by the surface tension e.g. water spider

Our focus here will be on floating on a liquid.

(Pg. 6/7)

2. Floatability

(a) the greater the amount of material above water, the greater the floatability;

(b) the greater the force required to push the material under the water line, the greater the floatability;

kitchen scales upside down | Hanging weights | Marbles placed on nylon netting fixed to bottom

(Pg. 14)

Questions (Set H)

1. Why did the LISP team not include a labelled section on the scientists' view of the phenomena dealt with in the experimental projects 2, 3 and 4?

2. Are the teachers able to understand the background information provided?

3. Do teachers appreciate being provided with a brief statement of the scientists' view of a phenomenon where they are provided?

4. What use(s) do teachers make of the background information provided?

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6. Children's Ideas

One of the major differences between this and almost all other handbooks for primary science is the emphasis placed in the LISP handbook on teachers knowing about the ideas their pupils bring to their lessons.

- Teachers are urged to find out what questions their own pupils have about floating and sinking.

- A summary is provided of the sorts of questions children ask.

- A summary is provided of the ideas children commonly have about floating and sinking.

- For each of the investigations and for the first of the experimental projects a brief statement of commonly-held children's views is provided.

Questions (Set I)

1. Do teachers appreciate being provided with background on the ideas of children?

2. What use do teachers make of this background information?

3. Are teachers who use the LISP material more aware of the ideas held by children in their class than teachers using materials, e.g. Department of Education units, which do not provide such information?

4. Do teachers who use the LISP material treat children's ideas with greater respect than teachers using materials, e.g. Department of Education Units, which do not provide such information?

7. Sequencing of Activities

The LISP handbook presents three sets of activities:

- a set of investigations in which children's misconceptions are directly tested;

- a set of experimental projects through which children can test their ideas;

- a set of non-experimental projects reflecting the relationship between science and society;

It is likely that teachers would take this to be the recommended sequence to be followed.

In the likelihood that time is short the teacher may decide to delete the third section or both the second and the third section.

Questions (Set K)

1. On what grounds do the LISP team believe that the sequence they suggest is the most appropriate?

2. Do teachers use the handbook activities in the sequence suggested?

3. Do teachers interpret the sequence as indicating an order of priorities or a developmental pattern?

4. If teachers are forced to use only parts of the Unit which parts are deleted?

Within the three sections teachers may interpret the order of presentation as significant whereas this may not have been the intention of the authors. Of particular interest is the order in the suggested investigations.

The first of these is more traditional in its approach than the later three. In the first the learning experiences are designed to lead the children to appreciate that objects will float if they are light for their size and sink if they are heavy for their size. The three activities which follow this one are designed to lead students to refute ideas found to be commonly held.

Questions (Set L)

1. What were the authors' intentions in arranging the activities in this order?

2. Do teachers see significance in this order? If so, what significance?

4. Are teachers more likely to undertake Investigation 1 than Investigations 2, 3 and 4?

8. Model of Science

As was indicated in the section on objectives, the LISP handbook argues that through the activities the children should recognise that ideas in science must be testable. Further, it is pointed out that:

> "All but the first investigation may be considered unusual in that they are designed to refute ideas not to confirm them. However, scientists use this method all the time. By this means, understanding is gained through systematically eliminating possible explanations." (Pg. 8/9)

Questions (Set M)

1. Are teachers who use the LISP unit conscious of the acceptability of experimentally based refutation as a means of scientific progress?

2. Do the teachers who use the LISP unit consider the idea of setting up experimental tests to refute or confirm children's ideas to be an appropriate basis for science education?

3. Do teachers believe that if scientists sometimes use such methods to test their own ideas then this endorses the value of the approach in the classroom?

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9. Attitudes to the Learning of Science

In the LISP unit the hope is expressed that the children will come to recognise that science can help them make better sense of the world.

Questions (Set N)

1. Do teachers accept that the activities will assist children to recognise that science can help them make better sense of the world?

2. Does the use of the LISP unit encourage children to recognise that science can help them make better sense of their world?

10. Teaching Strategies

The LISP handbook suggests two overall teaching strategies. The first is that the teacher allows children to devise methods of investigating their own questions and explanations. The second is that the teacher selects activities from those suggested in the book and involves the pupils in those selected.

Questions (Set O)

1. What proportion of the teachers who use the unit choose to use the detailed activities suggested rather than build directly on their children's ideas?

2. What reasons do teachers give for choosing to develop their own programs rather than using the activities detailed in the LISP handbook?

3. When teachers develop their own programs, in what ways are they different from the sequence of activities outlined in the LISP handbook?

10.1 The investigations

When the investigations suggested are examined, it is found that Investigations 2, 3 and 4 present a common strategy: the handbook suggests a simple activity which would generate data relevant to a question, a method of recording the data, and that the pupils record their conclusion in their own words.

Investigation 1 differs from this in one respect. In addition to asking the pupils to record their own explanations, it is suggested that the teacher record the scientists' explanation in a class summary.

Questions (Set P)

1. Why did the LISP authors suggest that for Investigation 1 the scientists' view be recorded in the class summary whereas they make no similar suggestion for the other investigations and projects?

10.2 The experimental projects

The second set of activities in the LISP handbook are the experimental projects. The authors indicate that the main emphasis in the section is 'on the children recognizing that ideas in science must be testable'. At that level there is uniformity: all of the projects involve the children in activities to test ideas. However, at the detailed level there is no uniformity in the strategy suggested.

Questions (Set Q)

1. Do the teachers who use the LISP material feel that more guidance is required for the experimental projects?

2. What strategies do teachers use for the experimental projects?

3. When teachers use the suggested strategies do the pupils come to recognise that ideas in science must be testable?

10.3 The non-experimental projects

For the third set of activities, the non-experimental projects, very little guidance is offered as to teaching strategies.

Questions (Set R)

1. Why did the LISP authors provide relatively little guidance about teaching strategies for the non-experimental projects?

2. Do the teachers who use the LISP material feel that more guidance is required for the non-experimental projects?

3. What strategies do the teachers use for these projects?

4. Are the objectives for the projects realised?

CONCLUSION

The authors of the handbook believe that with respect to the LISP approach there are two groups of teachers, those who feel confident to act independently when the approach is explained to them and those who need some support and guidance for the first part of the journey into the world of children's ideas. It is for the latter group that the handbook is written. The important issue is whether these teachers simply use it as another unit of work or whether it opens their eyes to the possibilities of working from children's ideas and provides a model they can use to do that. Hence an evaluation of the impact of this handbook needs to involve not only looking at what happens when it is used but seeing what happens in the classrooms after it is used.

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APPENDIX

Q. 1. What is the LISP approach?

A. 1. Broadly speaking its AIM is to help children make better sense of their world through developing particular kinds of skills and basic information about natural phenomena. The METHOD employed is the use of teaching sequences and strategies which encourage teachers to use and build upon children's present ideas, and the ORIENTATION is one which will provide children with knowledge that pupils, teachers and the community consider to be of some present or future personal usefulness.

Q. 2. Why was this booklet produced when the Education Department already had a unit on the topic?

A. 2. We chose the topic as one that met the criteria we proposed elsewhere (Harlen & Osborne, 1983) without concern as to whether or not there was a Department of Education unit on it. We also felt that a booklet of suggestions for teachers should contain some indication of children's ideas (something which the Departmental Resource units do not do) together with suggestions as to how children's ideas might be challenged, clarified or extended. It is hoped that this would provide teachers with understanding of, and better reasons to help children with, learning in science.

Q. 3. What purpose do you hope the booklet will serve?

A. 3. It is a prototype for high support material based on the LISP approach. That is, it will provide us with a vehicle to evaluate the extent to which material presented in this form can influence teacher behaviour and children's learning. It will also provide science advisers, teachers college lecturers and curriculum developers with an example of the LISP approach in action.

(Appendix - cont.)

Q. 4. Why didn't you produce a labelled set of objectives for the unit?

A. 4. We are not sure that objectives always have to be tabulated. Our objectives are stated, as you have been able to identify, but they are not collected. Our personal experience is that we tend to jump rapidly over tables of objectives - but maybe others need them. We were a little concerned that a set of objectives labelled in the traditional way might interfere with our effort to communicate with teachers in a fresh kind of way in order to convey to them a need to think in terms of children's learning. There was also the thought that unexpected but valuable outcomes would be more readily accepted by teachers if objectives were not specified in the usual manner. In other words, our concern was not to prescribe what teachers should achieve but to help them into a different teaching role.

Q. 5. Do you believe that the set of statements I have gathered from the unit actually represent the objectives of the unit?

A. 5. These would be some of the main intentions.

Q. 6. There isn't in the booklet any substantial comment on skill development which could occur when pupils use the unit. Why is that?

A. 6. Skills should develop naturally as needs arise to solve certain problems. In our view, skills have been over-emphasized and artificially fragmented by the Syllabus and, as a consequence skills may well have been played down by us to make a point. Questioning, and investigating to answer a question, are the two skills of importance in our view. Further, we would prefer to wait and see what skill development does occur when the unit is used with children, or what is potentially possible through such use. Then we would be in a much better position to include suggestions in the booklet about skill development, rather than

(Appendix - cont.)

specifying in advance what could occur. We feel we do not know enough about children's skill development yet to make confident statements about it.

Q. 7. What leads you to believe that the knowledge gained from the non-investigable projects could be described as knowledge of social value?

A. 7. The concerns of this section are with the relationship of the topic to the real world. For example, there are environmental issues associated with oil as a floater, and safety issues associated with lifeboats - most children seem to feel that these matters are important to them.

Q. 8. Is there a reason why you didn't specify a time allocation for the topic?

A. 8. Yes. We do not know how long it will take. Why should we stipulate, and on what basis? Perhaps we should state that the length of the unit will depend on pupil enthusiasm and teacher judgement. It may well be better to stop the topic, within reason, before the pupils become bored with it.

Q. 9. In the first of the experimental projects you included a labelled statement on the scientists' view. Why didn't you do that for the other projects?

A. 9. In Investigation 1, the scientists' view does not follow directly from the evidence available. We are telling them what scientists have found out from a wide range of experiences and investigations. If you like, it is an advance organiser. However, it is an important point; our intent is not made clear.

(Appendix - cont.)

Q. 10. On what grounds would you justify the sequence of activities you have suggested?

A. 10. The idea of floating and sinking is located in a network of understandings. In our view, the initial activity provides an experimental basis for later activities.

Q. 11. Investigation 1 is more in line with traditional teaching whereas Investigations 2, 3 and 4 are based on refutation. By placing the more traditional activity first do you see any likelihood of teachers doing Investigation 1 but not 2, 3 and 4?

A. 11. It is possible, but we feel that they are likely to be interested to find out what their children's views are on these aspects too. If they were the other way around then it may result in them not doing any.

Q. 12. What were the reasons for providing relatively little guidance about teaching strategies for the non-experimental projects?

A. 12. We were conscious of the amount of reading already required by the unit and thought that teachers might be able to handle these 'social studies type' activities without detailed guidance. Whether they can or not remains to be seen.